This electrical control equipment is designed to be installed, operated, and maintained by adequately trained workmen. These instructions do not cover all details, variations, or combinations of the equipment, its storage, delivery, installation, check-out, safe operation, or maintenance. Care must be exercised to comply with local, state, and national regulations, as well as safety practices, for this class of equipment. The maximum short circuit capability of the equipment should not be exceeded by connection to a source with higher capacity.

If maintenance or troubleshooting assistance is required, contact your nearest Cutler-Hammer Sales Office.
Part 1. General Information

The Motor Control Center
The Cutler-Hammer IT. Motor Control Center may be joined to existing Five Star, Series 2100, Freedom 2100 and Advantage installations using the splice bar kits common to both. Units designed for the IT MCC can be mounted in Advantage and Freedom 2100 sections, and Advantage and Freedom 2100 units can be mounted in IT structure. The IT. MCC may be joined to existing Cutler-Hammer Freedom Unifont and F10 Unifont MCC’s with a special splice bar kit, but units are not interchangeable.

Control Center Nomenclature
The numbers shown in parentheses in the following text refer to the balloon legends in Figure 2. The Cutler-Hammer IT. Motor Control Center consists of one or more totally enclosed, dead front, free standing structural assemblies (17) 90 inches high which are compartmentalized to house individual control units. (2) With control units mounted in the front side only, the structure may be 16 or 21 inches deep. For mounting units back-to-back, the structure is 21 inches deep. Steel covers (7) enclose the structure at the top, sides and at the rear of frontmounted-only structures.

A vertical copper ground bus (20) is located in each structure and provides grounding for each unit via a ground stab. A 24V dc bus (22) provides distribution of control voltage to each unit in a structure. The 24V control voltage is generated by a 24V dc power supply unit (5) and is distributed to each unit through a control stab.

A vertical bus system (13) installed in each vertical section is connected to the horizontal bus to feed the individual control units. (14) The vertical bus is isolated by a full height barrier. (6) An optional labyrinth barrier provides both isolation and insulation. An automatic shutter is included with the labyrinth barrier system to cover the stab openings for each control unit.

At the bottom of each section, a door (18) provides ready access to the bottom horizontal wireway, (19) and neutral bus (if provided). The bottom of each section is completely open to provide unrestricted bottom entry of cable and conduit. Channel sills may be installed across the bottom of the control center if specified, and an optional bottom plate may also be specified.

A vertical wireway 8 inches deep, (16) extending the full 90 inch height of the control center is located to the right of each unit compartment. This wireway is covered by two hinged doors (15) and contains cable supports to secure wire bundles and cables. The vertical wireway joins the horizontal wireway at the top and bottom to provide unobstructed space for interwiring.

Each vertical section provides space to mount up to eleven controller units (2) with a minimum height of 6 inches, in increments of six inches, for a total of 72 inches of usable space. Controllers through NEMA Size 5 are drawout type. These drawout unit assemblies are a completely self-contained package consisting of a steel enclosure, operating handle and electrical components. The drawout assembly slides into this compartment on guide rails (11) to provide easy withdrawal and reinsertion and to ensure precise alignment of the unit stabs with the vertical bus. Each drawout unit is held in place by a single quarter-turn latch (4) which can only be engaged when the unit stabs are fully mated with the vertical bus. Each unit has a separate door, (1) held closed by quarter-turn fasteners. The operating handle on the controller unit (3) Rotates. In the ON or TRIPPED positions, the handle interlocks with the unit door to prevent its opening. In this position, authorized personnel can open the door by turning the defeater mechanism screw. (21) With the unit door open and the operating handle in the ON position, another interlock to the divider pan prevents removal of the unit. (4) This same interlock prevents insertion of the unit unless the handle mechanism is in the OFF position.

To ensure that units are not energized accidentally or by unauthorized personnel, the handle mechanism can be padlocked in the OFF position. Space for a minimum of three padlocks is provided on each handle.

Fig. 1. Nameplate

Ratings
Each IT. Motor Control Center has a rating nameplate attached to the door of the top horizontal wireway of the primary section. See Figures 1 and 2. This nameplate shows the general order number under which the motor control center was built and its continuous electrical ratings, in terms of incoming line voltage, phases, and frequency, and ampere ratings of the horizontal bus and the vertical bus for each section. In addition, this nameplate shows the passive short-circuit (withstand) rating of the horizontal and vertical bus system. The active short-circuit (interrupting) ratings of the main and unit short-circuit protective devices are shown on labels attached to the inside of each unit. Before installing a motor control center, calculate and record the fault current available at the incoming line terminals. Verify that the short-circuit withstand and short-circuit interrupting ratings of the units in the motor control center are appropriate for the fault current available.

Qualified Personnel
Individuals who install, operate or maintain motor control centers must be trained and authorized to operate the equipment associated with the installation and maintenance of a motor control center, as well as the operation of the equipment that receives its power from controller units in the motor control center. Such individuals must be trained in the proper procedures with respect to disconnecting and locking OFF power to the motor control center, wearing protective clothing and equipment, and following established safety procedures as outlined in the National Electrical Safety Code(ANSI C2) and Electrical Equipment Maintenance (NFPA 70B).

For more information visit: www.EatonElectrical.com
Fig. 2. Motor Control Center Nomenclature
Part 2. Receiving, Handling, and Storage

Receiving
Before and after unloading the motor control center, inspect each section and unit exterior for evidence of damage that may have been incurred during shipment. If there is any indication that the control center has been mishandled or shipped on its back or side, remove the drawout units and make a complete inspection of the internal structure, bus bars, insulators and unit components for possible hidden damage. Report any damage found to the carrier at once.

Handling
The following guidelines are provided to help avoid personal injury and equipment damage during handling, and to facilitate moving the motor control center at the job site.

General Hints
1. Handle the motor control center with care, to avoid damage to components and to the enclosure or its paint finish.
2. Keep the motor control center in an upright position.
3. Insure that the moving means has the capacity to handle the weight of the motor control center.
4. The control center should remain secured to the shipping skid until the motor control center is in its final location.
5. Exercise care during any movement and placement operations to prevent falling or unintentional rolling or tipping.
6. Lifting angles for handling by overhead crane are bolted to the top of each shipping section. Handling by overhead crane is preferable but when crane facilities are not available, the motor control center can be positioned with a fork-lift truck or by using rollers under the shipping skid.

Overhead Crane
1. See Figure 3 for recommended lifting configuration.
2. Select or adjust the rigging lengths to compensate for any unequal weight distribution, and to maintain the motor control center in an upright position.
3. To reduce tension on the rigging and the compressive load on the lifting angles, do not allow the angle between the lifting cables and vertical to exceed 45 degrees.
4. Use slings with safety hooks or shackles. Do not pass ropes or cables through lifting angle holes.
5. After removing the lifting angles, replace the mounting hardware to prevent the entrance of dirt, etc.

Fork-lift Truck
Motor control centers are normally top and front heavy. Balance the load carefully and steady, as necessary, while moving. Always use a safety strap when handling with a fork-lift.

Rollers
Rod or pipe rollers, with the aid of pinch bars, provide a simple method of moving the motor control center on one floor level, if there is no significant incline. Roll the motor control center slowly, and steady the load to prevent tipping.

Storage
When a motor control center cannot be installed and placed into operation immediately upon receipt, take steps to prevent damage by condensation or harsh environmental conditions. If the motor control center cannot be installed in its final location, store it in a clean, dry, ventilated building, heated to prevent condensation, and protected from dirt, dust, water, and mechanical damage. When storage conditions are less than ideal, install temporary electrical heating, typically in the form of light bulbs, totaling 150 watts per section, hung in the vertical wireway, or by applying power to self-contained space heaters that the motor control center may be equipped with. Remove all loose packing and flammable materials before energizing any of the heating elements.
Part 3. Installing Control Center Sections

General
T. Motor Control Centers (MCC's) are designed for installation in accordance with both the National Electrical code (NEC), NFPA 70, and the National Electrical Safety Code (NESC), ANSI C2.
Caution – If work is involved in connecting the control center with existing equipment, ensure that incoming power is disconnected before work is begun. Disconnecting means should be locked out and/or tagged out of service. Where it is not feasible to de-energize the system, the following precautions should be taken:
A) Persons working near exposed parts that are or may be energized should be instructed and should use practices (including appropriate apparel, equipment, and tools) in accordance with the NESC.
B) Persons working on exposed parts that are or may be energized should, in addition, be qualified persons who have been trained to work on energized circuits.

Installation
1. Before any installation work is begun, consult all drawings furnished by Cutler-Hammer as well as all applicable contract drawings for the installation. Give particular attention to the physical location of units in the control center and their relation to existing or planned conduit, busways, etc. Provide for future conduit entrance prior to control center installation.
2. Locate the control center in the area shown on the building floor plans. If in a wet location or outside of the building, protect the control center from water entering or accumulation within the enclosure. Recommended clearances or working spaces are as follows:
   a) Clearance from walls (where not rear accessible) – a minimum of 1/2 inch for indoor and 6 inches for outdoor or wet locations.
   b) Clearance from front of MCC (working space) – minimum of 3 feet for control centers without exposed live parts. See NEC 110-16d. NOTE: This working space should not be used for storage and should have adequate lighting.
3. Since control centers are assembled at the factory on smooth and level surfaces to assure correct alignment of all parts, control centers should be securely mounted on a level surface. The foundation furnished by the purchaser must be true and level, or the bottom frames must be shimmed to support the entire base in a true plane. It is recommended that leveled channel sills under both the front and rear of the control center be used to provide this level base. Drill an tap the channel sills for mounting bolts in accordance with the applicable floor plan drawing and then either install the MCC level with, or on top of, the finished floor. If sills are grouted in concrete, the mounting bolts should be screwed in place and remain until the concrete has hardened.
4. For bottom entry, position the motor control center so that the conduit stubs or floor openings are located in the shaded areas shown on the MCC floor plan drawings (refer to pages 31 to 32 for floor plan dimensions). The shaded areas represent the open space available for conduit entry through the bottom of each section. A shaded area may be restricted if large controllers or autotransformers are mounted in the bottom of the sections. If optional bottom plates are supplied, the plates may be removed and drilled for conduit entry.
5. Install the MCC in its final position, progressively leveling each section and bolting the frames together if they are separated. If necessary, secure the MCC to walls or other supporting surfaces. Do not depend on wooden plugs driven into holes in masonry, concrete, plaster, or similar materials. See NEC 110-13.
6. If two or more shipping sections are to be joined into an integral assembly or a shipping section is to be joined to an existing section, refer to paragraphs below before proceeding with the installation.
7. Ground and bond the motor control center as follows:
   a) Motor control centers used as service equipment for a grounded system or as an incoming line section for a separately derived previously grounded system:
      i) Run a grounding electrode conductor (ground wire) having a size in accordance with NEC 250-94 from the grounding electrode to the MCC ground bus or ground terminal provided. See also NEC 250-91(a) and 92(b).
      ii) If the system is grounded at any point ahead of the MCC, the grounded conductor must be run to the MCC in accordance with NEC 250-23(b), and connected to the ground bus terminal.
      iii) Do not make any connections to ground on the load side of any neutral disconnecting line or any sensor used for ground-fault protection. Do not connect outgoing grounding conductors to the neutral.
   b) Motor control centers used as service equipment for an ungrounded system or as an incoming line section for a separately derived previously ungrounded system: i) Run a grounding electrode conductor (ground wire) having a size in accordance with NEC 250-94 from the grounding electrode to the MCC ground bus terminal. See NEC 250-91(a) and 92(b).
   c) Motor control centers not used as service equipment nor as an incoming line section for a separately-derived system, and used on either a grounded or ungrounded system:
      i) Ground the MCC ground bus by means of equipment grounding conductors having a size in accordance with NEC 250-95 or by bonding to the raceway enclosing the main supply conductors in accordance with NEC 250-91(b).
8. When all wiring and adjustments are complete, close all unit and wireway doors.
9. In damp indoor locations, shield the MCC to prevent moisture and water from entering and accumulating.
10. Unless the motor control center has been designed for unusual service conditions, it should not be located where it will be exposed to ambient temperatures above 40°C (104°F), corrosive or explosive fumes, dust, vapors, dripping or standing water, abnormal vibration, shock or tilting.
Part 3. Installing Control Center Sections (Continued)

Joining Compatible Sections
If two more shipping blocks are to be joined into an integral assembly, or a section added to an existing installation, splicing or horizontal bus, ground bus, neutral bus and joining of the adjacent vertical sections must be planned with the installation.

1. Remove the side sheets from adjacent vertical sections to be joined. (These sheets will have been removed from factory-assembled sections.)

2. The horizontal bus splice plates and connection hardware will be shipped with the MCC attached to one end of shipping section. Refer to Figure 1.

3. Remove the upper horizontal wireway door from the structure on the right side of the lefthand (LH) section and remove the two-piece wireway barrier to provide access to the ends of the bus in that section. 4. Move the section in place, aligning the upright structural channels and bottom channels. Alignment of the section with floor sills and foundation provisions will be facilitated by removing the bottom horizontal wireway doors. Using the "U" type frame clamps provided, clamp adjacent front upright channels together at the top, bottom and approximate center of the vertical structure. This operation will be facilitated by removing the vertical wireway doors from the left-hand structure and one or more drawout units from the right-hand structure. See Part 9.

5. If rear access is available, "U" clamps should also be used to clamp the rear upright channels together. In front-mounted-only structures this will require removal of the adjacent back sheets. In a back-to-back mounted structure, remove the vertical wireway doors and one or more drawout units as above.

6. Secure the sections to the floor sills or mounting bolts as provided for the installation.

7. Bolt the horizontal bus splice plates to the bus in the left-hand structure, torquing all bus splice bolts to 360 pound-inches (30 pound-feet). See Figure 5.

8. Replace all unit, bus barriers, and doors.

Joining Incompatible Sections
Joining An IT Motor Control Center to other equipment such as Type W and 11-300 Control Centers will usually involve a transition section, installed between the two varieties of equipment. This transition section will be detailed on drawings provided by Cutler-Hammer and the applicable contact drawings. If provided separately, it should be installed first. Review the overall installation task to determine whether the transition section should be attached to the existing equipment or to the IT section, before it is moved into place, and select the sequence which will provide best access to bus splicing and joining of the structures.
Part 3. Installing Control Center Sections (Continued)

Splice Plates
Each splice plate kit consists of short pieces of bus bar the same width as the main horizontal bus of the MCC the kit is shipped with, four bolts per phase, and appropriate quantities of related hardware. For a single bus bar per phase the hardware is used as shown in Figure 6 for either 16” or 20” deep enclosures. Each splice plate is punched with rectangular holes to accept a square shank carriage bolt that will not rotate as the nut is tightened.

Where the MCC is built with two horizontal bus bars per phase, the splice plates are installed as shown in Figure 7. The top edge of Figures 7 through 10 represents the backside of the MCC. The top portion of each of these figures applies to 20” deep enclosures and the lower portion to 16” deep enclosures. Note that for all but the single-bar per phase (Figure 6) installation, the 16” deep enclosures require the use of a nut plate that is mounted with the same carriage bolt used to attach the horizontal bus bars to the channel-shaped insulators. Install these nut plates before mounting the splice plates. Tighten the splice plate bolts with a driving torque of 360 pound-inches (30 pound-feet).

Type 3R Enclosures
Where the MCC is supplied in a Type 3R enclosure for an outdoor application, apply roof splice caps at each shipping block junction to maintain the enclosure integrity.

Fig. 7. Double Bar Splice Kit

Fig. 8. Triple Bar Splice Kit

Fig. 9. Quadruple Bar Splice Kits
Part 3. Installing Control Center Sections (Continued)

Joining IT Communicating MCC Sections
When joining IT MCC sections together there will be a DeviceNet connection and possibly a QCPort connection that must be made. The DeviceNet cable splice is made in the upper horizontal wireway. This connection is a 5 pin mini connector. Connect the cable located in the right hand section (see figure 11) to the Tee connector located in the left hand section. If there is a QCPort Connection that needs to be made (refer to your Network diagram to see which structures have QCport Jumpers) there will be a QCport jumper located in the bottom horizontal wireway. There are two (2) QCport Connection located in the bottom wireway, one of these may have QCport jumper in it already (see figure 12). Connect the jumper located in the left-hand structure to the QCPort connectors located in the right-hand structure’s bottom wireway. (See Figure 13) If both connection ports are open connecting the jumper to either of the two ports is acceptable however connecting to the top port is recommended.

Fig. 10. Six and Eight Bar Splice Kits

Fig. 11 DeviceNet Trunk Cable.

Fig. 12 QCPort jumper connection.

Fig. 13 QCPort jumper to adjacent structure.
Part 3. Installing Control Center Sections (Continued)

Joining IT to Freedom Unitrol or F10 Unitrol
Consult the assembly instruction supplied with every IT Motor Control Center set up for splice to Freedom Unitrol or F10 Unitrol.

Fig. 14a. Splice Plates Attached to Freedom 2100 Horizontal Bus and Ground Bus at Top

Fig. 14b. Horizontal Bus Splice Freedom Unitrol on Left, Freedom 2100 on Right.

Fig. 14c. Splice Plate Attached to IT. Ground Bus at Bottom.

Fig. 14d. Splice Plate Attached to IT. Neutral Bus.
Part 4. Installing Conduit and Wiring

Conduit
Install conduit in such a manner as to prevent water from entering and accumulating in the conduit or the enclosure. Eliminate sags in conduit. Have the conduit enter the motor control center (MCC) in the areas designated for conduit entry on the plan views. See pages 31 and 32 of this booklet and outline drawings shipped with the MCC. Keeping conduit within the shaded areas shown in the plan views will avoid cable interference with structural members and live bus. See Part 12.

Wiring
Install the line and load conductors sized in accordance with the NEC. Use copper wire only for control terminations. Use copper wire only for power terminations unless they are marked “CU/AL.” Use conductors with a temperature rating of 75°C or higher, but regardless of the insulation temperature rating select the wire size on the basis of 75°C wire ampacity. Using a higher temperature wire ampacity table often results in a smaller crosssection of copper available for carrying heat away from terminals.

Install insulated wire and cable at a temperature sufficiently warm to prevent the insulation from cracking or splitting. When more than one conduit is run from a common source or to a common load, be sure to have each conduit carry conductors from each phase and the same number of conductors per phase. If the phase conductors are not distributed uniformly, eddy currents will be generated in the steel between the conduits. Locate conductors within the MCC to avoid physical damage and to avoid overheating. Secure incoming power lines in a manner adequate to withstand the forces which will act to separate the conductors under short-circuit conditions. Use the cable ties furnished in both horizontal and vertical wireways to support the load and interconnection wire. Use a shielded communications cable inside of flexible metal conduit to protect very low voltage signals transmitted to or from a computer or programmable controller.

Lugs furnished with the MCC and its components are for Class B and Class C stranding. Verify the compatibility of wire size, type, and stranding with the lugs furnished. Where they are not compatible, change the wire or lugs accordingly. If crimp lugs are used, crimp with the tools recommended by the manufacturer.

Use care in stripping insulation to avoid nicking or ringing the metal. All field wiring to control units should be made in accordance with the wiring drawings that are furnished with the control center. Load and control wiring can be brought in through the upper and/or lower horizontal wireways. Determine the type of wiring installed in the control center (NEMA Type B or C) and proceed per the following appropriate paragraph.

The phase sequence of the power circuit load terminals (top-to-bottom: T1, T2, T3) in units mounted on the rear side of the MCC is opposite to that of the load terminals in units mounted on the front side of a back-to-back MCC. To obtain the same direction of rotation for a motor connected to a rear-mounted unit as for one connected to a front-mounted unit re-label the terminals in the rear-mounted unit: T3, T2, T1, and wire accordingly. Refer to the warning sticker supplied with rear-side units. When making power connections to the starter terminals, be sure to leave sufficient slack in the wires so that the unit can be withdrawn to the detent position for maintenance. See page 20.

NEMA Type B Wiring
Each control unit is factory assembled with devices inter-wired within the unit. In addition, all control wiring is carried to unit terminal blocks mounted on the right-hand side of the unit. See Figure 15. Bring the field wiring of control wires from a horizontal wireway into the vertical wireway on the right-hand side of the applicable control unit and terminate them at the unit terminal blocks.

Bring load wiring from the vertical wireway, under the bottom right-hand side of the unit, to terminations within the unit. If optional Load Terminals are provided terminate Load wires to Load terminals located adjacent to the Vertical wireway. To gain access to these terminal place tool between right hand wrapper side and wireway post as shown in figure 15a.

Engaging Pull-apart Terminal Blocks
The male portion of the pull-apart terminal block is located in a plastic bag tied to the wrapper side of the unit. This terminal block can be wired outside of the vertical wireway. To engage the terminal block, align the fingers of the male connector with the slot at the back of the female portion of the terminal block. Slide terminal block to the left until the male snaps into the female.

Each male portion also has a rear slot that can engage the edge of the unit frame where it can be mounted for ease in troubleshooting.
Part 4. Installing Conduit and Wiring (Continued)

NEMA Type C Wiring
Each control unit is factory assembled with devices inter-wired within the unit. In addition, all control wiring is carried to unit terminal blocks on the side of the unit and from these unit blocks, along with load wiring through Size 3, to master terminal blocks located at the top or bottom of the structure. See Figure 16. Master terminal blocks can be either fixed or drawout mounted. In the drawout design the terminal blocks are rack mounted to permit withdrawal of the entire assembly for ease of wiring during installation and maintenance. Bring field wiring from the horizontal wireway to the master terminal blocks except for load wiring larger than Size 3. These latter load wires should be carried into the vertical wireway and under the bottom right-hand side of the unit to terminations within the unit.

Fig. 16. Master Terminal Block
Part 5. Incoming Line Connections

Overcurrent Protection
All ungrounded conductors in a motor control center (MCC) installation require some form of overcurrent protection in order to comply with Section 240-20 of the NEC. Such overcurrent protection for the incoming lines to the MCC is in the form of fuses or a circuit breaker located at the transformer secondary that supplies the MCC. The conductors from the transformer secondary constitute the feeder to the MCC, and the “10-foot rule” and the “25-foot rule” of NEC, 240-21 apply. These latter exceptions to the general rule allow the disconnect means and overcurrent protection to be located in the MCC, provided the feeder taps from the transformer are sufficiently short and other requirements are met.

A circuit breaker or a circuit interrupter combined with fuses controlling the power to the entire MCC may provide the overcurrent protection required as described above or may be a supplementary disconnect (isolation) means. See Figures 17, 18, and 19.

When the MCC has a main disconnect, bring the incoming lines (the feeders) to the line terminals of the circuit breaker or circuit interrupter. The load side of the circuit breaker or the load side of the fuses associated with the circuit interrupter has already been connected to the MCC bus bar distribution system. In the case of main disconnects rated 400 amperes or less, this load connection is made by stab connections to vertical bus bars which connect to the horizontal bus distribution system. See Figure 17.

Fig. 17. Main Disconnect with Stab Load Connections
overcurrent protection to be located in the MCC, provided the feeder taps from the transformer are sufficiently short and other requirements are met.

Note that with reverse feed the bottom terminals of the circuit breaker are still energized when the circuit breaker is turned off!

Fig. 18. Main Circuit Breaker with Reverse Feed

Fig. 19. Main Circuit Breaker
Part 5. Incoming Line Connections (Continued)

Incoming Line Lugs
Where the overcurrent protection for the MCC is at a remote location, the MCC feeder lines are connected to incoming line lugs attached to the bus bar distribution system. See Figure 20. For highampere rated horizontal bus bar systems, the incoming line lugs are mounted on vertical risers, which connect to the horizontal bus bars. See Figure 21.

Short-circuit Bracing
All incoming lines to either incoming line lugs or to main disconnects must be braced to withstand the mechanical forces created by a high fault current. With the remainder of a Freedom 2100 MCC brad for not less than 65,000 amperes (rms symmetrical), the installing electrician needs to anchor the cables at the incoming line connections sufficiently and tighten the lugs correctly. Each incoming line compartment is equipped with a two-piece spreader bar located about nine inches from the conduit entry. Use this spreader bar an appropriate lacing material to tie cables together where they can be bundled and to hold them apart where they are separated. In other words, position the incoming line cables and then anchor them in place. See Figure 22 and the instruction sheet inside of the MCC.

Making Connection
CAUTION: All incoming line compartments present an obvious hazard when the door is opened or covers are removed with power on. When working in this area, the incoming feeder should be de-energized.

Before beginning work on incoming line connections, refer to all drawings furnished by Cutler Hammer as well as all applicable contract drawings for the particular installation.

Depending on the location, size and type of the incoming arrangement, remove one or more horizontal and vertical wireway doors, and selected units to provide complete access. See Part 9 for unit removal instructions.

For top entry, the top cover plates are easily removed for drilling or punching operations.
Part 6. Overcurrent Protection Devices

Device Selection
Articles 240 and 430 of the NEC contain the rules for selecting fuses, circuit breakers and overload relays by type and by voltage and ampere rating. Follow these rules for feeder circuits, and the instructions attached to the inside of the left-most vertical wireway door, for motor branch circuits. Select and install overload relay current elements (heaters) based on the motor service factor and full-load current. Ambient compensated overload relays are used in motor control centers (MCC's) to offset the temperature gradient which occurs from top to bottom in a loaded vertical section.

IT. Electronic Overload Relays (Fig. 24)
Electronic type Overload Relays are provided on IT. Starters. Features include:
- Selectable Manual or Automatic Reset operation.
- Adjustable 3.2 to 1 to match motor FLA and calibrated for use with 1.0 and 1.15 service factor motors.
- Programmable for Class 10, 20 or 30 applications.
- Electronic ambient compensated operation.
- Electrically isolated NO contacts (push TEST button to test).
- Overload trip indication.
- Single phase protection and Phase unbalance Protection.
- UL listed, CSA certified, KEMA certified, CE and NEMA compliance.

IT. Overload Relay Setting
FLA DIAL ADJUSTMENT – For motors having a 1.15 service factor, rotate the FLA adjustment dial to correspond to the motor’s FLA rating. Estimate the dial position when the motor FLA falls between two values as shown in Fig. 23.
For motors having a 1.0 service factor, rotate the FLA dial one-half position counterclockwise (CCW). MANUAL/AUTOMATIC RESET – The overload relay is factory set for manual reset operation as shown in Fig. 23. For automatic reset operation, turn the reset adjustment dial to the automatic position.
Automatic reset is not intended to two-wire devices.
TEST FOR TRIP INDICATION – To test overload relay for trip indication when in manual reset, push the black reset button. The red trip LED will start flashing indicating that the device has tripped. When the LED begins to flash rapidly push reset button to reset.
TEST FOR TRIP INDICATION – To test overload relay for trip indication when in automatic reset, push the black reset button. The red trip LED will start flashing indicating that the device has tripped. The starter will automatically reset when the reset button is pressed.
WARNING – To provide continued protection against fire or shock hazard, the complete overload relay must be replaced if burnout of the heater element occurs.
CURRENT TRANSFORMERS
When current transformers are used with overload relays, the current through the overload relay heater is related to the motor full-load by the inverse of the current transformer ratio.
WARNING: Do not ever remove OL block from Size 5 and larger starters to check unit operation. These starters use current transformers to drop the current to the range of the size 0 overload relay. Operation with overload removed will not interrupt voltage to the motor and will generate dangerous voltages in the open secondary of the current transformer.
Part 6. Overcurrent Protection Devices (Continued)

Motor Circuit Protector (HMCP)
Where the overcurrent protection for the MCC is at a remote
AFTER INSTALLATION OF THE CONTROL CENTER, EACH MCP MUST BE ADJUSTED TO ACTUAL MOTOR FULL-LOAD AMPERES (FLA) SO THAT IT WILL TRIP AT ANY CURRENT WHICH EXCEEDS STARTING INRUSH. This setting provides low-level fault protection. The first halfcycle inrash will vary with the motor characteristics. Motors with locked-rotor currents of six times motor full-load amperes will usually require an instantaneous magnetic setting of 7 to 11 times motor full-load amperes to prevent tripping when starting.

A cam to accept a small narrow-blade electrician’s screwdriver is near the lower left corner and around which are eight lettered adjustment points, calibrated in trip amperes. See Figure 24. Adjustment should never exceed 17 times FLA which is in accordance with NEC requirements for magnetic-trip-only breakers. Adjustment should be made as follows:
1. Obtain FLA from motor nameplate.
3. Set the cam to the highest trip setting which does not exceed the calculated figure of Item 2. This is the maximum setting that should be used.
4. Depress and turn the screwdriver adjustment counter-clockwise one setting at a time, until the breaker trips in starting and then adjust upward one setting position. This will insure that the circuit will open instantly on any current above the motor inrush, usually 7 to 11 time FLA.

The PUSH-TO-TRIP button checks the tripping function and is used to periodically exercise the operating mechanism. The button is designed to be operated by using a small screwdriver. Freedom 2100 MCC’s are supplied with Type HMCP motor circuit protectors having an interrupting rating to match the short-circuit withstand rating of the bus bar system. For HMCP’s in 225, 400, and 600 ampere frame sizes, the magnetic-trip adjustment is set for each pole. A three-pole HMCP has three trip settings to adjust. Place all three poles at the same setting.

Current Limiters for use with Type HMCP And FD Breakers
The addition of the current limiter provides interrupting capacity above the range handled by the HMCP in motor starters or by FD thermal-magnetic feeder breakers. Each HMCP or FD breaker rated up to 150 amps has its own current limiter to provide coordinated protection against faults up to 100,000 amperes, rms symmetrical. Built-in trip indicators in each phase immediately show when a fault has blown the current limiter and tripped the circuit breaker. This provides protection against single phasing. After interrupting a fault, the current limiter will require replacement. After the fault has been cleared, the current limiter is replaced by the removal of three screws. The breaker can then be reset to provide for subsequent high overcurrent protection.

Type HMCP and FD Circuit Breakers with Terminal End Covers
Circuit breakers installed in units connected to 600 volt distribution systems require a terminal end cap to be installed on the line side. Replace the terminal end cap when replacing circuit breakers in such units.
Part 7. Overload Relay Selection and Set Up

OL Selection and Installation
Over Load relay should be selected on the basis of the actual full load current and service factor as shown on the motor nameplate or in the motor manufacturer’s published literature. When motor and overload relay are in the same ambient and the service factor of the motor is 1.15 to 1.25, select OL and set FLA adjustment dial from the FLA dial. If the service factor of the motor is 1.0, or there is no service factor shown, rotate the FLA adjustment dial counter-clockwise one half (1/2) position.

To set the FLA:
A. Open the IT. Overload Relay cover.
B. Turn the FLA/CLASS dial to the motor’s full load current rating.
   THE OVERLOAD IS NOW SET FOR 1.15 SERVICE FACTOR.
C. If the motor nameplate is 1.0 service factor, rotate the FLA Adjustment dial counter-clockwise on half (1/2) position.
D. The overload is factory set for MANUAL reset operation. If automatic reset is required, turn the reset adjustment dial to AUTO. Automatic reset is not intended for two-wire control devices.

Overload Class Setting:
The IT. Overload can be set to provide Class 10, 20 or 30 overload protection, with or without phase loss/unbalance protection. The factory default is class 20 for NEMA starters, with phase loss/unbalance protection enabled, and the motor FLA level set to minimum.
When the 24V DC control power is first applied, the status LED on the overload will flash to indicate the current Class setting and phase protection status. See Figures 25b and 25c. If a different Class or phase protection choice is desired, the selection can be changed with the TEST button and FLA/CLASS dial using the procedure below.
To access the FLA/CLASS dial for this adjustment, the hinged cover over the dial must be opened. If the cover has been tied closed by a wire tie or other tie down through the slotted lock bar, the tie down will need to be removed first. The closed cover is illustrated in Figure 25a. The FLA/CLASS dial is illustrated in Figure 25. The FLA markings will vary by catalog number, but the CLASS markings are as shown.

1. Remove the main 3 phase AC input power. Connect the 24V DC control power. Note that the STATUS LED will flash rapidly, followed by the Trip Class code as shown in Figure 25b or 25c.

2. Open the IT. Overload Relay cover.
3. Turn the FLA/CLASS dial fully clockwise
4. Push and hold the TEST button.
5. When the STATUS LED flashes, rotate the FLA/CLASS dial fully counterclockwise without pausing during the rotation.
6. After the STATUS LED flashes at least 5 times, rotate the FLA/CLASS dial to one of the six positions as indicated on the label – 10, 20, or 30 with Phase Protection On or 10, 20, or 30 with Phase Protection Off as illustrated in Figure 25d.

7. The STATUS LED will continuously indicate the Trip Class code (one flash for Class 10, two for Class 20, and three for Class 30) and repeat as long as the TEST button is depressed.
8. Release the TEST button. The STATUS LED will flash rapidly, followed by the Trip Class code as shown in Figure 4 or 5. If not, repeat this procedure starting with step 3.
9. Proceed to the overload FLA setting section.

Note that the overload Trip Class must be set prior to adjusting the overload FLA setting if different than the factory default.
Part 7. Overload Relay Selection and Set Up (Continued)

Phase Loss and Current Unbalance Protection

General
Phase loss and current unbalance protection will occur as noted in the following two sections. These indications are accurate when the actual line currents are at least 75 percent of the minimum FLA rating for the IT. Overload Relay. For example, if the current range of an overload is 10 to 32 amps, the minimum value for accurate sensing is 0.75 x 10 7.5 amps.

If desired, the phase loss and phase current unbalance protection functions may be disabled during the class selection process. See the Overload Class Setting section for more information.

If the 24V DC control power is removed during the phase loss or unbalance trip condition, when the 24V DC control power is restored, the STATUS LED and ALARM indication will activate for 2.5 minutes. After the delay, the LED will begin to flash rapidly. A reset is not possible until this rapid flash occurs.

Phase Loss
If one input line voltage is lost, with the line current going to zero for longer than 10 seconds, a phase loss trip will occur. The starter is tripped, and the alarm output is set on. The STATUS LED will flash at a 0.5 seconds on then 0.5 seconds off rate for 10 seconds, after which it will flash rapidly until the trip is reset as shown below. The rapid flash indicates that the overload relay may be reset. When the overload relay is reset the ALARM INDICATION is also reset.

Phase Current Unbalance
A phase current unbalance trip will occur if one or two of the line currents are 50 percent or less of the remaining line(s) for longer than 10 seconds. The starter is tripped, and the alarm output is set on. The STATUS LED will flash at a 0.5 seconds on then 0.5 seconds off rate for 10 seconds, after which it will flash rapidly until the trip is reset as shown in Figure 7. The rapid flash indicates that the overload relay may be reset. When the overload relay is reset the ALARM INDICATION is also reset. See the Trip Reset section below for more reset information.

Overload Protection
The overload protection is based on a calculation using the motor full load amp setting, the overload Class selection, the actual measured current, the motor operating time and its off time. This information is used to create a thermal memory in the microprocessor, which simulates the motor’s thermal condition. The thermal memory is indicated by the blink rate of the STATUS LED which is proportional to the motor’s calculated thermal condition as shown below.

The STATUS LED will indicate the motor’s thermal condition, even when the starter is not closed, as long as the 24V DC control power is applied to the + and – terminals. If an overload condition occurs, the IT. Overload Relay is tripped and the ALARM INDICATION is turned on. The microprocessor will continue to calculate the motor’s thermal condition. When it is at 75% or less, the STATUS LED will begin flashing rapidly indicating that the trip may be reset. Upon reset, the STATUS LED will blink at a rate which is proportional to the present motor thermal condition.

If the Auto Reset feature is enabled and the start circuit is closed, when the motor thermal condition returns to 75% or less, the overload will automatically reset and the starter will close. Caution must be exercised when using the Auto Reset feature to prevent unintended operation.

Alarm Without Trip Function
In some applications continued operation is a critical requirement, although damage to the motor or driven equipment may result. If the Alarm Without Trip function is enabled and an overload, phase loss or phase current unbalance condition occurs, the ALARM INDICATION is turned on but the IT. Overload Relay will not be tripped. By setting this function on, the user accepts responsibility for any damage or hazards that may occur as a result of the user’s decision to disable the protective trips.

To enable this feature, the RESET button must be turned to the AUTO position and the Remote Reset terminal 4 of the IT. MCC must be connected to the + when using 24V DC control power or L1 when using 120V AC control power. The STATUS LED behavior will be the same as outlined above. This feature does not function when the TEST button is used to trip the IT. Overload Relay.

Any time the Remote Reset is Jumped and the starter has a trip condition the Run light will remain on and will be flashing. This is to indicate that the if the motor is running the reset button is in the auto position and the alarm without trip function is activated.

Trip Reset
After a trip condition has occurred, the IT. Overload Relay must be reset before operation may resume. There are three choices for resetting the trip: manual, remote, and auto. After the fault cause has been cleared and the thermal memory of the IT. Overload Relay is at 75% or less, the STATUS LED will begin to flash rapidly. At this time the IT. Overload Relay may be reset.

<table>
<thead>
<tr>
<th>Thermal Memory</th>
<th>Status LED</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than 70%</td>
<td>Off</td>
</tr>
<tr>
<td>70% – 80%</td>
<td>1 Flash</td>
</tr>
<tr>
<td>80% – 90%</td>
<td>2 Flashes</td>
</tr>
<tr>
<td>90% – 95%</td>
<td>3 Flashes</td>
</tr>
<tr>
<td>95% &lt; 100%</td>
<td>4 Flashes</td>
</tr>
<tr>
<td>&gt;100%</td>
<td>Steady On (Trip)</td>
</tr>
</tbody>
</table>

COOLING 2.4-14 MINUTES
## Part 7. Overload Relay Selection and Set Up (Continued)

### OL Troubleshooting Chart

<table>
<thead>
<tr>
<th>Observation</th>
<th>Possible Cause/Corrective Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>STATUS LED always on, Contact Block will not close</td>
<td>Overload has tripped on a fault. Wait between 2.5 – 14 minutes for thermal memory to reach 75% level if tripped on overload. Do not remove 24V DC control power to avoid thermal memory reset to the prior fault trip level. If overload cannot be reset, replace.</td>
</tr>
<tr>
<td>STATUS LED always on, Contact Block closed</td>
<td><em>IT.</em> Overload Relay set to Alarm Without Trip, overload has occurred. See Alarm Without Trip section.</td>
</tr>
<tr>
<td>STATUS LED flashing, Contact Block closed</td>
<td>The calculated motor thermal condition is above 70% as shown by flash rate. This is normal operation. See Overload section.</td>
</tr>
<tr>
<td>STATUS LED flashing, Contact Block closed</td>
<td><em>IT.</em> Overload Relay set to Alarm Without Trip, but has tripped on phase loss/phase current unbalance. This is normal operation. See Alarm Without Trip and Phase Loss and Phase Current Unbalance sections.</td>
</tr>
<tr>
<td>STATUS LED flashing, Contact Block open</td>
<td>Slow flash. TEST button pressed or jammed. See TEST Button Operation.</td>
</tr>
<tr>
<td>STATUS LED flashing, Contact Block open</td>
<td>Phase loss/unbalance trip just occurred. LED should begin to flash rapidly after approximately 10 seconds.</td>
</tr>
<tr>
<td>Cannot Set Class</td>
<td>Proper procedure not followed. See Overload Class Setting.</td>
</tr>
<tr>
<td>STATUS LED does not flash on power up</td>
<td>Unit tripped - STATUS LED on constant. Cannot set Class if tripped. Wait for STATUS LED to begin flashing rapidly, reset and then try again.</td>
</tr>
<tr>
<td>Check 24V DC control power supply at control terminal block +/- connections.</td>
<td></td>
</tr>
<tr>
<td>Check control wiring.</td>
<td></td>
</tr>
</tbody>
</table>
**Part 7. Overload Relay Selection and Set Up (Continued)**

**OL Troubleshooting Chart (Continued)**

<table>
<thead>
<tr>
<th>Observation</th>
<th>Possible Cause/Corrective Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>RESET button does not reset the Overload Relay (Local or remote)</td>
<td>IT. Overload Relay not ready to be reset. STATUS LED must be flashing rapidly before reset can occur. Wait and try again. See Trip Reset.</td>
</tr>
<tr>
<td></td>
<td>RESET button not pressed long enough. Must be pressed for at least 1 second.</td>
</tr>
<tr>
<td>ALARM INDICATION not functional</td>
<td>Check wiring of user supplied power supply. If more than 28V DC was applied to terminals the output will be damaged. See Alarm Indication section, replace overload.</td>
</tr>
<tr>
<td>STATUS LED does not flash rapidly after trip times out, it just goes out</td>
<td>Is unit tripped? Alarm output is active only if unit is tripped or TEST button is pressed. Use TEST button to verify operation. See Test Button Operation section.</td>
</tr>
<tr>
<td></td>
<td>Overload Relay set for Auto Reset. Check the position of integral RESET button.</td>
</tr>
<tr>
<td></td>
<td>Remote RESET button is pressed or closed</td>
</tr>
<tr>
<td></td>
<td>Check terminal block wiring to remote RESET input. See the Control Wiring section of the /T. Contactor and Starter User Manual.</td>
</tr>
</tbody>
</table>

**Overload Selection Chart**

<table>
<thead>
<tr>
<th>Starter Size</th>
<th>Max Current Rating</th>
<th>Current Range</th>
<th>Part Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>27</td>
<td>.25-8 .59-1.9 1.4-4.4 2.8-9.0 5.0-16 8.4-27</td>
<td>N05NCXRANA N05NCXRBNA N05NCXRCNA N05NCXRDNA N05NCXRFNA N05NCXRHNA</td>
</tr>
<tr>
<td>2</td>
<td>45</td>
<td>5-16 8.4-27 14-45</td>
<td>N05NDXRFNA N05NDXRHNA N05NDXRKNA</td>
</tr>
<tr>
<td>3</td>
<td>90 135</td>
<td>28-90 42-135</td>
<td>N05NEXRMNA N05NEXRPNA</td>
</tr>
<tr>
<td>5 (300/5 CT Ratio)</td>
<td>270</td>
<td>84-267*</td>
<td>N05NBXRCNA</td>
</tr>
<tr>
<td>6 (600/5 CT Ratio)</td>
<td>540</td>
<td>168-528*</td>
<td>N05NBXRCNA</td>
</tr>
<tr>
<td>7 (1000/5 CT Ratio)</td>
<td>810</td>
<td>280-880*</td>
<td>N05NBXRCNA</td>
</tr>
</tbody>
</table>

* FLA marked on OL multiplied by transformation ratio
Part 8. Inspection Prior to Energizing

1. Before energizing the motor control center (MCC), conduct a thorough inspection to make certain that all foreign materials such as tools, scraps of wire and other debris are removed from all units and the structure. Remove any accumulation of dust and dirt with a vacuum cleaner.

2. All circuit connections are tightened at time of assembly by power-driven tools with controlled torque. However, the vibrations experienced in transit may loosen some of these connections. Check at least 10% of the total connections for a tight connection. Should this spot-check reveal some loose connections, it will be necessary to check all connection points. The connections to be checked include bus hardware, circuit breaker and switch terminals, contactor and relay terminals and terminal blocks. Always check the incoming line connections. Tighten to the torque values shown in Tables 8-1.

3. Remove all blocks or other temporary holding means used for shipment from all component devices in the MCC interior.

4. Check the enclosure to see that it has not been damaged so as to reduce electrical spacings.

5. Compare all circuits for agreement with the wiring diagrams which accompany the MCC. Be sure that each motor is connected to its intended starter.

6. Make certain that field wiring is clear of live busses and physically secured to withstand the effects of fault current.

7. Check to determine that all grounding connections are made properly.

8. Check all devices for damage. Make all necessary repairs or replacements, prior to energizing.

9. Manually exercise all switches, circuit breakers, and other operating mechanisms to make certain that they are properly aligned and operate freely.

10. Test any ground-fault protection systems that were furnished.

11. Set any adjustable current and voltage trip mechanisms to the proper values.

12. Ensure that overload relay selected matches the full-load current shown on the nameplate of each motor.

13. Install power circuit fuses in the fusible switches in accordance with NEC application requirements. Make sure that fuses are completely inserted in the clips provided. Do not attempt to defeat the rejection feature on the fuse clip, when provided.

14. Do not operate a current transformer with its secondary circuit open. Insure current transformer is connected to a load, or a secondary shorting bar is installed.

15. To prevent possible damage to equipment or injury to personnel, check to insure that all parts and barriers that may have been removed during wiring and installation have been properly reinstalled.

16. Conduct an electrical insulation resistance test to make sure that the MCC and field wiring are free from short circuits and grounds. Do this test phase-to-phase, phase-to-ground, and phase-toneutral, with the switches or circuit breakers opened.

17. If the MCC contains a labyrinth vertical bus barrier system, verify the operation of the automatic shutters. See Part 9 for adjustments of this mechanism.

18. Install covers, close doors, and make certain that no wires are pinched and that all enclosure parts are properly aligned and tightened.

19. Turn all circuit breakers and fusible switches to the OFF position before energizing the bus.

Table 8-1 Driving Torque

<table>
<thead>
<tr>
<th>Control Wiring:</th>
<th>Torque (lb.-in.)</th>
<th>Tool Size (HEX)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Relays</td>
<td>8 lb.-in.</td>
<td></td>
</tr>
<tr>
<td>Push Buttons</td>
<td>8 lb.-in.</td>
<td></td>
</tr>
<tr>
<td>Control Fuse Blocks</td>
<td>8 lb.-in.</td>
<td></td>
</tr>
<tr>
<td>Auxiliary Contacts</td>
<td>8 lb.-in.</td>
<td></td>
</tr>
<tr>
<td>Control Wiring Terminal Blocks</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Side Mounted Lug/Compression</td>
<td>4.5 lb.-in.</td>
<td></td>
</tr>
<tr>
<td>Rail Mounted Lug Type</td>
<td>12 lb.-in.</td>
<td></td>
</tr>
<tr>
<td>Rail Mounted Compression Type</td>
<td>18 lb.-in.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Power Wiring: Starters</th>
</tr>
</thead>
<tbody>
<tr>
<td>Device</td>
</tr>
<tr>
<td>Size 1 and 2 Load terminal</td>
</tr>
<tr>
<td>Size 3 and 4 Load Terminal</td>
</tr>
<tr>
<td>Nema size 1</td>
</tr>
<tr>
<td>Nema size 2</td>
</tr>
<tr>
<td>Nema size 3 and 4</td>
</tr>
<tr>
<td>Nema size 5</td>
</tr>
<tr>
<td>Nema size 6</td>
</tr>
<tr>
<td>Nema size 7</td>
</tr>
</tbody>
</table>

* Torque ranges are shown as 100% rated value.

Control Wiring:
- 30 Amp Fuse Assay | 25 lb.-in.
- 60 Amp Fuse Assay | 50 lb.-in.
- 100 Amp Fuse Assay | 50 lb.-in.
- 200 Amp Fuse Assay | 300 lb.-in.
- 400 Amp Fuse Assay | 300 lb.-in.
- 600 Amp Fuse Assay | 300 lb.-in.

BREAKERS- Refer to Torque Values on Breaker Case

Incoming Line Lugs:
- #2/0-350 MCM | 360 lb.-in.
- #2/0-650 MCM | 360 lb.-in.
- #2/0-750 MCM | 500 lb.-in.
- 500-1000 MCM | 600 lb.-in.

Bus Bolts:
- All | 275 lb.-in.(23lb.-ft.)
Part 9. Unit Installation and Adjustment

Door Removal and Installation
All doors on the control center are mounted on pin hinges to facilitate removal for installation and maintenance operations. With the operating handle on the OFF position, rotate the quarter-turn latches, open the door, remove the hinge pins as shown in Figure 26, partially close the door and lift it from the structure. Reverse this procedure for installation.

Unit Removal and Installation
After opening and/or removing the unit door, the control unit is exposed. With a screwdriver, rotate latch located to the left of the operator handle 1/4 turn counterclockwise. CAUTION: Units 18” or more high have a retaining screw at the lower edge of each side of the unit frame to add stability in shipping. The shipping screws may be retained or removed after installation; unscrew prior to unit withdrawal. Pull-apart terminal blocks in the vertical wireway must be disengaged (see Figure 27 and page 10) and wiring from the unit to other units, to master terminal blocks or to load devices must be disconnected before the unit is removed. Grasp the unit as shown in Figure 28 and pull it outward. The first inch of travel pulls the stabs free from the vertical bus, and the grounding clip on the side of the unit frame is also disengaged.

To replace a control unit, position the mounting points on the unit frame with the mating guide rails. Slide the unit inward until unit is 1/2 way in, then move it inward with a quick push. This movement easily overcomes the compression of the stabs as they engage the vertical bus. With the unit in its correct position, the quarter-turn latch is easily engaged by rotating 1/4 turn clockwise. If the latch will not rotate the unit is not fully inserted.
Part 9. Unit Installation and Adjustment (Continued)

Detent Position
For maintenance and test purposes, the unit can be partially withdrawn (approximately 1 1/2 inches) until the stabs are free of the bus. In this position, the quarter-turn latch can be rotated clockwise to engage the detent position slot; this will secure the unit to ensure the stabs remain disengaged during maintenance. See Figure 29. The latch can be padlocked in this position.

![Unit Locked in Detent Position](image1)

Automatic Shutter Travel Adjustment
When the optional labyrinth vertical bus barrier is installed in the control center, a shutter is provided to automatically cover the stab openings when a control unit is withdrawn. The shutter is opened by engagement of the left-hand side of the control unit with the shutter arm linkage attached to the left-hand vertical structural members. When the unit is withdrawn free of the linkage, a spring automatically moves the shutter to its closed position. See Figure 30.

With the control unit removed, the shutter should completely cover the stab openings. If it does not cover the openings, use an adjustable wrench to bend the link arm to the right until the shutter covers the stab openings.

If, on re-insertion of the control unit, interference is felt between the stab assembly at the rear of the unit and the shutter, the engagement of the control unit with the shutter arm linkage is insufficient to fully open the shutter. Use an adjustable wrench to bend the linkage arm inward toward the unit to increase its engagement with the unit. An inward bend of approximately 1/4 inch will provide sufficient additional shutter travel.

![Shutter Arm Linkage](image2)

1/4 Turn Unit Interlock
The quarter turn unit interlock is used to secure the unit into the structure. It also serves as the interlock to insure that a unit is not removed or inserted while the disconnect is in the on position. If a unit disconnect cannot be turned on verify that the unit interlock is in the engaged or locked position. This position is when the slot is parallel to the floor. If a unit cannot be withdrawn verify that the unit inter lock is fully in the unlocked or disengaged position. The interlock is fully disengaged when the slot is rotated 1/4 turn counter clockwise from parallel to the floor.

Cover Control Module
The cover control module has a number of trouble shooting features:

E-stop alert – When a unit E-stop circuit is opened the control voltage to the coil is interrupted. This will disable the starters. When this occurs the green Stop indicator on the cover control module will begin to flash.

Alarm without Trip
This feature allows the starter to remain energized after an over load occurs. This can be used for critical loads when over loading the motor is safer than shutting it down. To engage this feature jumper the reset circuit (terminal 1) on the interface module to the proper control voltage. Then place the OL relay to Automatic restart by adjusting the dial on the face of the OL. When running in this condition the red Run indicator will flash. A non communicating unit will always flash the “Run” indicator when ever the reset input is held high.
Part 9. Unit Installation and Adjustment (Continued)

Power Supply Unit
Power supply units provide Control Power all units located in the same structure as the Power Supply unit. Turning off the disconnect to the power supply unit will remove control voltage to the entire structure. Power Supply units have a retaining bracket located in the right hand vertical wireway to prevent accidental removal. (See figure below) Observe the following procedure when replacing power supply units:

1. Verify that turning off control power to the structure will not cause an unsafe condition.
2. Open Power supply door (caution line voltage is present in this unit)
3. Turn off Power supply disconnect(s).
4. Remove Retaining Bracket
5. Remove unit.

Installing a New Unit
It is recommended that a new unit be installed in a unit space at the top of a vertical compartment or directly below an existing unit. Material provided with the new unit by the factory includes: A divider pan with integral guide rails, a unit door, hinges, catches and hardware. Observe the following sequence of operations for installation.

1. Remove the existing blank door.
2. Position the new unit door over the open space to ensure the hinges and latches are aligned. If the spaces differ, the hinges and latches on the structure must be re-located to match the unit door hinges and latches. Mount the door, using the hinge pins provided.
3. Install the new divider pan in the notches provided in the rear barrier so that it is aligned with the bottom of the new door. Attach the pan to the vertical structure channels with one thread-forming screw on each side.
4. Remove from the vertical bus barrier the flat plate which covers the stab holes that will align with the stabs on the new unit. If an optional labyrinth vertical bus barrier is in place, install an automatic shutter over the stab cutouts. Follow the instruction sheet provided with the shutter kit.
5. If the unit is a communicating unit, set the new unit’s address using the dip switched located at the right hand edge of the handle mechanism housing. Insure that another unit on the same network is not using the new unit’s address. To avoid address conflicts and to preserve your current I/O mapping it is recommended that the new unit be assigned the next address higher than the highest address currently on the network, even if skipped addresses exist.
6. Insert unit.
Part 10. Maintenance

Preventive Maintenance
Preventive maintenance should be a program, a scheduled periodic action that begins with the installation of the equipment. At that time, specific manufacturer’s instruction literature should be consulted, then stored for future reference. Follow-up maintenance should be at regular intervals, as frequently as the severity of duty justifies. Time intervals of one week, or one month, or one year may be appropriate, depending on the duty. It is also desirable to establish specific check lists for each control, as well as a logbook to record the history of incidents. A supply of renewal parts should be obtained and stored.

This control equipment is designed to be installed, operated, and maintained by adequately trained workmen. These instructions do not cover all details, variations, or combinations of the equipment, its storage, delivery, installation, check-out, safe operation, or maintenance. Care must be exercised to comply with local, state, and national regulations, as well as safety practices, for this class of equipment.

Authorized personnel may open a unit door of a motor control center (MCC) while the starter unit is energized. This is accomplished by defeating the mechanical interlock between the operating mechanism and the unit door. A counter clockwise quarter-turn of the slotted head screw located to the right of the operating handle will allow the door to open. See Figure 32.

When servicing and adjusting the electrical equipment, refer to the applicable drawings covering the specific motor control center (MCC) and any other related interconnection drawings. Follow any instructions, which may be given for each device.

A list of instruction leaflets covering standard components is shown on the back page of this manual. Any of these leaflets may be obtained by contacting your nearest Cutler-Hammer Representative.

General Guidelines – The whole purpose of maintaining electrical equipment can be summarized in two rules:

a. Keep those portions conducting that are intended to be conduction.

b. Keep those portions insulated that are intended to be insulated.

Good conduction requires clean, tight joints, free of contaminants such as dirt and oxides.

Good insulation requires the absence of carbon tracking and the absence of contaminants such as salt and dust that become hydroscopic and provide an unintended circuit between points of opposite polarity.

CAUTION: Maintenance of control components requires that all power to these components be turned OFF by opening the branch circuit disconnect means and withdrawing the unit to the detent position (see Figure 28) or removing the unit entirely from the MCC. When units are fully inserted into the MCC, the line side of each disconnect is energized. Do not work on fixed units unless the main disconnect for the MCC is OFF.

When working on portions of a branch circuit remote from the MCC, lock the disconnect means for that circuit in the OFF position. To positively lock the operating mechanism in the OFF position, a metal locking bar recessed in the handle may be extended and padlocked with from one to three padlocks. See Figure 33.

When using scissors locks for applications that require multiple padlocks a minimum diameter is necessary for engagement of the locking bar. A diameter of .245” is required when the scissors lock is closed for minimum engagement.
Part 10. Maintenance (Continued)

![Correct and Incorrect Scissors Lock Application](image)

Figure 34 shows the acceptable means of engagement of a scissors lock with both interlocking tabs creating the diameter needed for minimum engagement.

Figure 35 shows an improper installation in which only one of the interlocking tabs is engaged with the lockout bar. This is not providing the sufficient diameter needed to engage the lockout bar.

With the door open and the disconnect device OFF, the operating handle is mechanically interlocked to prevent inadvertently being pushed ON. To defeat this interlock, the bar on the top of the mechanism should be pushed in slightly, allowing the handle to move upward to the ON position. **WARNING**: IF FULLY INSERTED, THE POWER AND CONTROL CIRCUITS WILL BE ENERGIZED. Padlocking to prevent this handle movement may be accomplished by the same method as described above.

Separate control sources of power must also be disconnected. If control power is used during maintenance, take steps to prevent feedback of a hazardous voltage through a control transformer. Be alert to power factor correction capacitors that may be charged. Discharge them before working on any part of the associated power circuit.

Cleaning. Soot, smoke, or stained areas (other than inside arc chutes), or other unusual deposits, should be investigated and the source determined before cleaning is undertaken. Vacuum or wipe clean all exposed surfaces of the control component and the inside of its enclosure. Equipment may be blown clean with compressed air that is dry and free from oil. (Be alert to built-in oilers in factory compressed air lines!) If air blowing techniques are used, remove arc covers from contactors and seal openings to control circuit contacts that are present. It is essential that the foreign debris be removed from the control center, not merely rearranged. Control equipment should be clean and dry. Remove dust and dirt inside and outside the cabinet without using liquid cleaner. Remove foreign material from the outside top and inside bottom of the enclosure, including hardware and debris, so that future examination will reveal any parts that have fallen off or dropped onto the equipment.

If there are liquids spread inside, determine the source and correct by sealing conduit, adding space heaters, or other action as applicable.

**Mechanical checks.** Tighten all electrical connections. Look for signs of overheated joints, charred insulation, discolored terminals, etc. Mechanically clean to a bright finish (don’t use emery paper) or replace those terminations that have become discolored. Determine the cause of the loose joint and correct. Be particularly careful with aluminum wire connections. Aluminum wire is best terminated with a crimp type lug that is attached to the control component. When screw type lugs (marked CU/AL) are used with aluminum wire, joint should be checked for tightness every 200 operations of the device.

Wires and cables should be examined to eliminate any chafing against metal edges caused by vibration, that could progress to an insulation failure. Any temporary wiring should be removed, or permanently secured and diagrams marked accordingly.

**Wrap-up.** Check all indicating lamps, mechanical flags, doors, latches, and similar auxiliaries and repair, if required. Log changes and observations into record book before returning equipment into service. Do not remove any labels or nameplates. Restore any that are damaged.

**Contact Wear And Replacement**

Contactors are subject to both mechanical and electrical wear during their operation. In most cases mechanical wear is insignificant. The erosion of the contacts is due to electrical wear. During arcing, material from each contact is vaporized and blown away from the useful contacting surface.

A critical examination of the appearance of the contact surfaces and a measurement of the remaining contact over-travel will give the user the information required to get the maximum contact life.

**Over-travel Measurement**

Contact life has ended when the over-travel of the contacts has been reduced to .020 inch.

Over-travel of the contact assembly is that part of the stroke which the moving contacts would travel after touching the fixed contacts if they were not blocked from movement by the fixed contacts.

A method of measuring over-travel is as follows:

a. Place a .020 inch feeler gauge between the armature and magnet, with the armature held tightly against the magnet.

b. Check continually in each phase, i.e., determine if circuit from terminal-to-terminal for each pole is open under these conditions.

c. If there is continuity through all phases, the remaining overtravel is sufficient. If there is not continuity through all phases, replace all stationary and moving contacts plus moving contact over-travel springs. After replacing parts, manually operate contactor to be sure binding does not occur.
## Part 10. Maintenance (Continued)

### Contactor Troubleshooting Chart

<table>
<thead>
<tr>
<th>Defect</th>
<th>Cause</th>
<th>Remedy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Short contact life</td>
<td>Low contact force</td>
<td>Adjust overtravel, replace contacts, and replace contact springs as required to correct contact force.</td>
</tr>
<tr>
<td></td>
<td>Contact bounce on opening</td>
<td>Correct improper voltage applied to coil. Correct any mechanical defects or misalignment.</td>
</tr>
<tr>
<td></td>
<td>or closing</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Abrasive dust on contacts</td>
<td>Do not use emery cloth to dress contacts.</td>
</tr>
<tr>
<td></td>
<td>Load current is too high</td>
<td>Reduce load. Use larger contactor.</td>
</tr>
<tr>
<td></td>
<td>Jogging cycle is too severe</td>
<td>Reduce jogging cycle. Check factory for more durable contact material. Use larger contactor.</td>
</tr>
<tr>
<td>Overheating</td>
<td>Load current too high</td>
<td>Install arc box.</td>
</tr>
<tr>
<td></td>
<td>Loose connections</td>
<td>Replace broken or eroded insulating parts, arc horns, and grid plates. Clean or replace insulating parts having a heavy coating of foreign conducting material.</td>
</tr>
<tr>
<td></td>
<td>Over-travel and/or contact</td>
<td>Remove contaminating materials which may have accumulated on arc horns and steel-grid plates.</td>
</tr>
<tr>
<td></td>
<td>force too low</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Ambient temperature is too high</td>
<td>Reduce load. Provide better ventilation. Relocate starter. Use larger contactor.</td>
</tr>
<tr>
<td></td>
<td>Line and/or load cables are too small</td>
<td>Install terminal block and run larger conductors between contactor and terminal block.</td>
</tr>
<tr>
<td>Welding of contacts</td>
<td>Overtravel and/or contact force is too low</td>
<td>Adjust overtravel, replace contacts, and replace contact springs as required to correct contact force.</td>
</tr>
<tr>
<td></td>
<td>Magnet armature stalls or hesitate at contact touch point</td>
<td>Correct low voltage at coil terminals as coil draws inrush current.</td>
</tr>
<tr>
<td></td>
<td>Contactor drops open to contact-touch position because of voltage dip</td>
<td>Maintain voltage at coil terminals. Install low voltage protective device, sometimes called “Brownout Protector”.</td>
</tr>
<tr>
<td></td>
<td>Excessive contact bounce on closing</td>
<td>Correct coil overvoltage condition.</td>
</tr>
</tbody>
</table>
Part 10. Maintenance (Continued)

Maintenance of Motor Controllers After a Fault

In a motor branch circuit which has been properly installed, coordinated and in service prior to the fault, opening of the branch-circuit short-circuit protective device (fuse, circuit breaker, motor short-circuit protector, etc.) indicates a fault condition in excess of operating overload. This fault condition must be corrected and the necessary repair or replacements made before re-energizing the branch circuit.

It is recommended that the following general procedures be observed by qualified personnel in the inspection and repair of the motor controller involved in the fault.

Procedure – Caution: All inspections and tests are to be made on controllers and equipment which are de-energized, disconnected and isolated so that accidental contact cannot be made with live parts and so that all plant safety procedures will be observed.

Enclosure. Substantial damage to the unit door or frame such as deformation, displacement of parts or burning, requires replacement of the entire unit.

Circuit breaker. Examine the unit interior and the circuit breaker for evidence of possible damage. If evidence of damage is not apparent, the breaker may be reset and turned ON. If it is suspected that the circuit breaker has opened several short-circuit faults or if signs of circuit breaker deterioration appear within the enclosure, the circuit breaker should be replaced.

Disconnect switch. The external operating handle of the disconnect switch must be capable of opening the switch. If the handle fails to open the switch or if visual inspection after opening indicates deterioration beyond normal wear and tear, such as overheating, contact blade or jaw pitting, insulation breakage or charring, the switch must be replaced.

Fuse holders. Deterioration of fuse holders or their insulating mounts requires their replacement.

Terminals and internal conductors. Indications of arcing damage and/or overheating such as discoloration and melting of insulation require the replacement of damaged parts.

Contactor. Contacts showing heat damage, displacement of metal, or loss of adequate wear allowance require replacement of the contacts and the contact springs. If deterioration extends beyond the contacts, such as binding in the guides or evidence of insulation damage, the damaged parts or the entire contactor must be replaced.

Overload relays. If burnout of the current element of an overload relay has occurred, the complete overload relay must be replaced. Any indication that an arc has struck and/or any indication of burning of the insulation of the overload relay also requires replacement of the overload relay.

If there is no visual indication of damage that would require replacement of the overload relay, the relay must be electrically or mechanically tripped to verify the proper functioning of the overload relay contact(s).

Return to service. Before returning the controller to service, checks must be made for the tightness of electrical connections and for the absence of short circuits, grounds an leakage. All equipment enclosures must be closed and secured before the branch circuit is energized.

Fig. 39. Normal Service Wear

Fig. 40. End of Service Life

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## Part 10. Maintenance (Continued)

### Table 10-1 Renewal Contact Kits, Coils & Overload Relays

<table>
<thead>
<tr>
<th>Description</th>
<th>NEMA Size 1</th>
<th>NEMA Size 2</th>
<th>NEMA Size 3</th>
<th>NEMA Size 4</th>
<th>NEMA Size 5</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Part No.</td>
<td>Part No.</td>
<td>Part No.</td>
<td>Part No.</td>
<td>Part No.</td>
</tr>
<tr>
<td><strong>CONTACT KITS</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3 Pole</td>
<td>EMHCKT40</td>
<td>EMHCKT65</td>
<td>EMHCKT125</td>
<td>EMHCKT160</td>
<td>6-45-2</td>
</tr>
<tr>
<td><strong>MAGNET COILS</strong></td>
<td>EMCC</td>
<td>EMCD</td>
<td>EMCE</td>
<td>EMCE</td>
<td></td>
</tr>
<tr>
<td>Line Voltage for Size 5-7</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>120V 60 Hz or 110V 50 Hz</td>
<td>A</td>
<td>B</td>
<td>C</td>
<td>L</td>
<td></td>
</tr>
<tr>
<td>240V 60 Hz or 220V 50 Hz</td>
<td></td>
<td></td>
<td>D</td>
<td></td>
<td>9-1891-1</td>
</tr>
<tr>
<td>480V 60 Hz or 440V 50 Hz</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>9-1891-2</td>
</tr>
<tr>
<td>600V 60 Hz or 550V 50 Hz</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>9-1891-3</td>
</tr>
<tr>
<td>380V 50 Hz</td>
<td></td>
<td></td>
<td>L</td>
<td></td>
<td>9-1891-4</td>
</tr>
<tr>
<td>415V 50 Hz</td>
<td></td>
<td></td>
<td>M</td>
<td></td>
<td>9-1891-14</td>
</tr>
<tr>
<td><strong>OVERLOAD RELAYS</strong></td>
<td>N05NCXRANA</td>
<td>N05NEXRMNA</td>
<td>N05NEXRPNA</td>
<td>N05NBXRDNA</td>
<td></td>
</tr>
<tr>
<td>N05NCXRBNNA</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N05NCXRCNNA</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N05NCXRFDNA</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N05NCXRHNNA</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Starter Type

<table>
<thead>
<tr>
<th>Description</th>
<th>Disconnect Means:</th>
<th>Unit Catalog Number Designation (Class)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Fusible</td>
<td>Circuit Breaker</td>
</tr>
<tr>
<td>Full Voltage, Non-Reversing</td>
<td>T204</td>
<td>T206</td>
</tr>
<tr>
<td>Full Voltage, Reversing</td>
<td>T214</td>
<td>T216</td>
</tr>
<tr>
<td>Full Voltage, Non-Reversing, 2 Speed, 2 Windings</td>
<td>T954</td>
<td>T956</td>
</tr>
<tr>
<td>Full Voltage, Non-Reversing, 2 Speed, 1 Winding</td>
<td>T944</td>
<td>T946</td>
</tr>
</tbody>
</table>
### Part 10. Maintenance (Continued)

#### Table 10-2 Communication Cover Control Troubleshooting

<table>
<thead>
<tr>
<th>LED State</th>
<th>Description</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mostly Off</td>
<td>Offline</td>
<td>Everything is working properly within the cover control and the cover control is not being scanned. Check that the Adaptor is commanded to scan QCPort.</td>
</tr>
<tr>
<td>Mostly On</td>
<td>Online</td>
<td>Everything is working properly within the cover control and the cover control is being scanned.</td>
</tr>
<tr>
<td>50% On</td>
<td>Faulted</td>
<td>Internal Memory Fault (cycle 24Vdc power). Verify that there are no duplicate Group ID addresses within a single adaptor. The Group ID was changed and a reset is required. Bus Fault. All the devices on the QCPort will have the same status LED behavior. A bus fault is caused by an open or shorted bus.</td>
</tr>
<tr>
<td>Eaton Green LED</td>
<td></td>
<td>The cover control has not been discovered/acquired by the network adaptor, verify that the node ID is set correctly for the system.</td>
</tr>
<tr>
<td>Rapid Flash</td>
<td>Unacquired</td>
<td>The network adaptor has not auto configured the QCPort system. In this case all of the cover controls will have the same behavior of the status LED. Perform an auto configuration. CH Studio is investigating that cover control. Remove the highlight of that bucket in CH Studio and the LED will go back to Mostly Off status.</td>
</tr>
<tr>
<td>Solid On</td>
<td>Download Mode</td>
<td>For communicating cover controls the unit is in a firmware download mode. Please cycle 24Vdc power. For non-communicating cover control the unit has 24Vdc and is working properly.</td>
</tr>
<tr>
<td>Solid Off</td>
<td>No Power</td>
<td>The cover control has no 24Vdc power to it. Check 24Vdc power supply output in top of structure.</td>
</tr>
<tr>
<td>Stop Light Flashing</td>
<td>E-Stop Circuit Open</td>
<td>The E-Stop Circuit is open. Check the 11 pin terminal block in the vertical wireway has a connection between E1 and E2. Check the terminal block located inside the bucket labeled E1, E2, +, E is properly installed.</td>
</tr>
<tr>
<td>Cover Control LED Indication Lights</td>
<td></td>
<td>This is a loss of communication between the cover control and starter. Verify that the harness between the cover control and the starter is correctly installed. For communicating version verify that the D77C-AC1 auxiliary contact is properly installed. Verify the starter has 24Vdc by pressing the test button. The status light on the starter should blink. If the cover control is moved from one starter to another with a different Overload range. A reset is required to rematch the cover control with the starter. Please see manual MN05009001 for further details.</td>
</tr>
</tbody>
</table>

Please review document MN05009001E for further trouble shooting and detailed information.
### Part 10. Maintenance (Continued)

Table 10-3 Non-Communication Cover Control Troubleshooting

<table>
<thead>
<tr>
<th>LED State</th>
<th>Description</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Eaton Green LED</strong></td>
<td>Solid on</td>
<td>Power on Unit is working properly. 24Vdc is being provided to the cover control from the 24Vdc bus in structure.</td>
</tr>
<tr>
<td></td>
<td>Off</td>
<td>No power The cover control has no 24Vdc power to it. Check 24Vdc power supply output in top of structure.</td>
</tr>
<tr>
<td><strong>Stop light flashing</strong></td>
<td>E-Stop Circuit Open</td>
<td>The E-Stop Circuit is open. Check the 11 pin terminal block in the vertical wireway has a connection between E1 and E2. Check the terminal block located inside the bucket labeled E1, E2, +, E is properly installed.</td>
</tr>
<tr>
<td><strong>Cover Control LED Indication Lights</strong></td>
<td>3 Phase Trip - OL Trip - Ground Fault Trip All Flashing</td>
<td>Fault This is a loss of communication between the cover control and starter. Verify that the harness between the cover control and the starter is correctly installed. For communicating version verify that the D77C-AC1 auxiliary contact is properly installed. Verify the starter has 24Vdc by pressing the test button. The status light on the starter should blink. A simulated OL Trip can be generated by holding down the test button on the starter overload for approximately 5 seconds. If the cover control is moved from one starter to another with a different Overload range. A reset is required to rematch the cover control with the starter.</td>
</tr>
<tr>
<td></td>
<td>Run Light ON and Stop Lights Flashing</td>
<td>This means that the starter is OFF yet there is still a valid RUN command on the Interface Module. This is to warn of a potential safety issue. Once the E-Stop Circuit is restored then the starter will close.</td>
</tr>
</tbody>
</table>

For more information visit: [www.EatonElectrical.com](http://www.EatonElectrical.com)
Part 10. Maintenance (Continued)

(1) Cover Control Module
(2) Cable Assemblies
(3) Door Interlock (included with item 1)
(4) IT Starter
(5) Quarter Turn Latch and Unit Interlock (included with item 1)
(6) Unit Guides (included with item 12)
(7) Unit Disconnect Device
(8) Stab Assembly
(9) Door Defeater Screw (included with item 1)
(10) Unit Terminal Blocks
(11) Interface Module
(12) Unit Wrapper
(13) Overload Cover
(14) Pilot Devices (included with item 1)

Fig. 41 Control Center Unit Nomenclature
Part 11. Plan Views

20 Inches Wide, 16 Inches Deep
Front Mounted Only (4710A30)

1. Minimum length of anchor bolt is 2.00". (3/8-16 grade 5 torqued at 31bf-ft).
   A. For non seismic, mount with 2 center bolts per enclosure.
   B. For seismic, mount with min 4 corner bolts per enclosure.

2. Recommended maximum conduit height above floor line is 3.50 inches.

3. Maximum conduit space with channel sills is 11.50 X 9.73 inches.

4. For multiple structure assemblies either one or both of these members are removed to provide maximum unrestricted conduit space at the bottom of the MCC.

5. This conduit space is not recommended when a neutral bus is required. Otherwise available.

See side View A. for right for vertical dimensions

24 Inches Wide, 16 Inches Deep
Front Mounted Only (4710A33)

1. Minimum length of anchor bolt is 2.00". (3/8-16 grade 5 torqued at 31bf-ft).
   A. For non seismic, mount with 2 center bolts per enclosure.

2. Recommended maximum conduit height above floor line is 3.50 inches.

3. Maximum conduit space with channel sills is 11.50 X 9.73 inches.

4. For multiple structure assemblies either one or both of these members are removed to provide maximum unrestricted conduit space at the bottom of the MCC.

5. This conduit space is not recommended when a neutral bus is required. Otherwise available.

See side View A. for right for vertical dimensions

20 Inches Wide, 21 Inches Deep
Front Mounted Only (4710A31)

1. Minimum length of anchor bolt is 2.00". (3/8-16 grade 5 torqued at 31bf-ft).
   A. For non seismic, mount with 2 center bolts per enclosure.

B. For seismic, mount with min 4 corner bolts per enclosure.

2. Recommended maximum conduit height above floor line is 3.50 inches.

3. Maximum conduit space with channel sills is 11.50 X 9.73 inches.

4. For multiple structure assemblies either one or both of these members are removed to provide maximum unrestricted conduit space at the bottom of the MCC.

5. This conduit space is not recommended when a neutral bus is required. Otherwise available.

See side View A. for right for vertical dimensions

24 Inches Wide, 21 Inches Deep
Front Mounted Only (4710A34)

1. Minimum length of anchor bolt is 2.00". (3/8-16 grade 5 torqued at 31bf-ft).
   a. For non seismic, mount with 2 center bolts per enclosure.

b. For seismic, mount with min 4 corner bolts per enclosure.

2. Recommended maximum conduit height above floor line is 3.50 inches.

3. Maximum conduit space with channel sills is 11.50 X 9.73 inches.

4. For multiple structure assemblies either one or both of these members are removed to provide maximum unrestricted conduit space at the bottom of the MCC.

5. This conduit space is not recommended when a neutral bus is required. Otherwise available.

See side View A. for right for vertical dimensions
Part 11. Plan Views  (Continued)

20 Inches Wide, 21 Inches Deep
Front and Rear Mounted (4710A32)

1. Minimum length of anchor bolt is 2.00". (3/8-16 grade 5 torqued at 31 lb-ft).
   a. For non seismic, mount with 2 center bolts per enclosure.
   b. For seismic, mount with 4 corner bolts per enclosure.
2. Recommended maximum conduit height above floor line is 3.50 inches.
3. Maximum conduit space with channel sills is 17.50 X 9.73 inches.
4. For multiple structure assemblies either one or both of these members are removed to provide maximum unrestricted conduit space at the bottom of the MCC.
5. This conduit space is not recommended when a neutral bus is required. Otherwise available.

See side View B. far right for vertical dimensions

10 Inches Wide, 16 or 21 Inches Deep
Transition Structure (4710A35/6)

1. Minimum length of anchor bolt is 2.00". (3/8-16 grade 5 torqued at 31 lb-ft).
   a. For non seismic, mount with 2 center bolts per enclosure.
   b. For seismic, mount with 4 corner bolts per enclosure.
2. Recommended maximum conduit height above floor line is 3.50 inches.
3. Maximum conduit space with channel sills is 17.50 X 9.73 inches.
4. For multiple structure assemblies either one or both of these members are removed to provide maximum unrestricted conduit space at the bottom of the MCC.
5. This conduit space is not recommended when a neutral bus is required. Otherwise available.

Side View A

Common Notes
7. Master Terminal Block assembly is furnished for type C wiring only when location not specified. MTB supplied at the bottom.
8. Rear horizontal bus barrier not supplied with front mounted only structure.
9. Standard structure arrangement:
   (a) In Front:
      Without MTB: A & B = 8"  
      With MTB at bottom: A & B = 9"  
      With MTB at top: A & B = 3"
   (b) In Rear:
      Without MTB: C = 0, D = 72", E = 3"  
      With MTB at bottom: C = 0, D = 66", E = 9"  
      With MTB at top: C = 12, D = 60", E = 3"

Side View B
Related Instruction Leaflets

Starters:
Size 1-5 Non Reversing and Reversing ........................................ ILMN03305001E
Size 6, Non-Reversing and Reversing ........................................ ILMN03305001E

Contactors:
Size 1-5 Non Reversing and Reversing ........................................ ILMN03305001E
Size 5, Non-Reversing and Reversing, vacuum ............................. ILMN03305001E

Circuit Breakers:
Series C, F-frame ........................................................................ IL01207002E
Series C, J-frame ........................................................................ IL01207002E
Series C, K-frame ........................................................................ IL01207002E
Series C, L-frame ........................................................................ IL01207002E
Series C, N-frame ........................................................................ IL01207002E
Series C, R-frame ........................................................................ IL01207002E
Series G, EG-frame ..................................................................... IL01207002E
Series G, JG-frame ..................................................................... IL01207002E
Series G, LG-frame ..................................................................... IL01207002E
Transfer Switches ........................................................................ IL01207002E

Cover Control:
QCPort Cover Control Programmer’s Manual ............................... MN05009001E

Communication Adaptors:
DeviceNet to QCPort Adaptors ................................................... MN05009001E
Ethernet IP to QCPort Adaptors .................................................. MN05009001E
Modbus TCP to QCPort Adaptor ................................................ MN05009001E
Profibus to QCPort Adaptor ....................................................... MN05009001E